



## **A flexible matrix-based human exposure assessment framework suitable for LCA and CAA**

**Jolliet, Olivier; Ernstoff, Alexi; Huang, Lei; Csiszar, Susan A.; Fantke, Peter**

*Published in:*  
International Society of Exposure Science 26th Annual Meeting - ISES2016

*Publication date:*  
2016

[Link back to DTU Orbit](#)

*Citation (APA):*  
Jolliet, O., Ernstoff, A., Huang, L., Csiszar, S. A., & Fantke, P. (2016). A flexible matrix-based human exposure assessment framework suitable for LCA and CAA. In *International Society of Exposure Science 26th Annual Meeting - ISES2016*

---

### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.



October 9-13, 2016

**Abstract book**

## Tu-SY-G4.2

### A flexible matrix-based human exposure assessment framework suitable for LCA and CAA

*Olivier Jolliet, University of Michigan, Ann Arbor, Michigan, United States*

*Alexi Ernstoff, Technical University of Denmark, Kgs. Lyngby, Denmark*

*Lei Huang, University of Michigan, Ann Arbor, Michigan, United States*

*Susan Csiszar, Oak Ridge Institute for Science and Education Research Participation Program at U.S. EPA, Oak Ridge, Tennessee, United States*

*Peter Fantke, Technical University of Denmark, Kgs. Lyngby, Denmark*

Humans can be exposed to chemicals via near-field exposure pathways (e.g. through consumer product use) and far-field exposure pathways (e.g. through environmental emissions along product life cycles). Pathways are often complex where chemicals can transfer directly from products to humans during use or exchange between near- and far-field compartments until sub-fractions reach humans via inhalation, ingestion or dermal uptake. Currently, however, multimedia exposure models mainly focus on far-field exposure pathways. Metrics and modeling approaches used in far-field, emission-based models are not applicable to all types of near-field chemical releases from consumer products, e.g. direct dermal application. A consistent near- and far-field framework is needed for life cycle assessment (LCA) and chemical alternative assessment (CAA) to inform mitigation of human exposure to harmful chemicals. To close the current research gaps, we (i) define a near- and far-field matrix-based exposure pathways framework that builds on a quantitative metric based on chemical mass in products, (ii) provide input data for the framework, e.g. chemical concentrations in products linked to functional use categories, and (iii) propose a consistent set of underlying models to populate the matrix-based framework for all relevant multimedia transfers and exposure pathways. Output is a flexible mass balance-based model structuring multimedia transfers in a matrix of first-order inter-compartmental transfer fractions. Inverting this matrix yields cumulative multimedia transfer fractions and exposure pathway-specific Product Intake Fractions defined as chemical mass taken in by humans per unit mass of chemical in a product. When the chemical mass in products is unavailable from individual studies and databases, it can be estimated from chemical-product function relationships or regulatory frame formulations. Combining Product Intake Fractions with chemical masses in products yields exposure estimates per unit mass compatible with LCA and CAA. We demonstrate how this matrix-based modeling system offers a consistent and efficient way to compare exposure pathways for different user groups (e.g. children and adults) and the general population exposed via the environment associated with product use. Our framework constitutes a user-friendly approach to test and interpret multiple human exposure scenarios in a coupled system of near- and far-field pathways and helps to understand the contribution of individual pathways to overall human exposure in various product application contexts. When combined with toxicity information this approach is a resourceful way to inform LCA and CAA and minimize human exposure to toxic chemicals in consumer products through both product use and environmental emissions.